

Research Approach

Work Plan/Experimental Design

AAT's proposed approach to this project is designed to achieve all project objectives, within the specified budget and schedule. The proposed project consists of six tasks which are described in the sections that follow.

Task 1: Literature Review

To effectively design the laboratory testing and data analysis for this project, the research team will undertake a limited literature review and a review of practice concerning the use of recycled asphalt binders in asphalt mixtures. The literature review will include:

1. A detailed review of the Wisconsin DOT criteria for binder replacement contained in Additional Special Provision 6.
2. A critical review of the work completed in NCHRP Project 9-12 to develop blending charts for RAP in performance graded binders, including NCHRP Report 452 (I) and NCHRP Web Document 30 (7).
3. Compilation of reported recovered binder properties for RAP, fractionated RAP, manufacturer RAS, and tear-off RAS.

The review of current practice will include a summary of allowable RAP and RAS percentages compiled from the state highway specifications contained on the FHWA National Specifications website (8) and the survey of state practice that was recently completed by the HMA Recycling Expert Task Group (9). The findings of this task will be included in the recommended experimental design developed in Task 2.

Task 2: Experimental Design

A detailed experimental design for the laboratory testing and analysis will be prepared in Task 2. The detailed experimental design will be a modification of the preliminary experimental design presented in this proposal. It will likely include 2 experiments as discussed below.

Experiment 1 AASHTO Blending Chart Improvements

In this experiment, two aspects of the current AASHTO blending chart testing and analysis will be investigated. The first is whether blending charts can be based on the properties of a 50/50 blend of virgin and recycled binders rather than 100 percent recycled binder to allow current testing equipment to be used with RAS binders. The second is whether PAV aging is needed for the recovered binders. Table 4 summarizes the factors that will be included in this experiment. The testing for this experiment includes:

1. Continuous grading of the two virgin binders per AASHTO R29.
2. Extraction, recovery and continuous grading of the RAP and fractionated RAP sources per the Appendix of AASHTO M323.

3. Extraction, recovery and continuous grading of the RAP and fractionated RAP sources per the Appendix of AASHTO M323 with PAV aging added.
4. Extraction, recovery and master curve testing of the two RAS sources per the Appendix of AASHTO M323.
5. Extraction, recovery and master curve testing of the two RAS sources per the Appendix of AASHTO M323 with PAV aging added.
6. Continuous grading of 16 blends of virgin and recycled binders (2 virgin binders x 4 recycled binders x 2 recycled binder percentages) per AASHTO R29.

Table 4. Factors for Experiment 1

Factors	Levels
Virgin Binders	PG 58-28
	PG 70-28
Recycled Binders	RAP Source 1
	Fractionated RAP Source 1
	Manufacturer RAS Source 1
	Tear-off RAS Source 1
Blends	25 % recycled binder
	50 % recycled binder

Experiment 2 Variability Analysis

It is likely that the variability of the binder properties from the four recycled asphalt sources will be different. Only limited data is currently available on the variability of the binder properties for various recycled sources. Experiment 2 is designed to determine initial estimates of the standard deviation for typical recycled asphalt sources in Wisconsin. This experiment will use a second source for each type of recycled binder so that typical properties for two sources of each type of recycled binder will be obtained in the project. Experiment 2 will involve determining continuous grade properties using the procedure established in Experiment 1 for multiple random samples from each source. Based on the available budget for the project, it is estimated that five random samples from each source can be tested. This will result in 20 characterizations of recycled binders using the procedure established in Experiment 1.

These preliminary experimental designs will be reviewed and modified based on the findings Task 1 and recommended experimental designs will be prepared for consideration by the Technical Oversight Committee (TOC). The Principal Investigator will meet with the TOC during Task 2 to finalize the experimental designs and to identify specific sources of materials for the study.

Task 3: Laboratory Testing

Task 3 includes procuring samples of virgin binders and recycled materials from Wisconsin sources identified by the TOC, and executing the testing plans developed in Task 2. The preliminary experimental designs discussed above include two virgin binders and two sources for each type of recycled binder. The required samples are relatively small. Experiment 1 will require 5 gallons of each virgin binder, 150 lbs. for the RAP and fractionated RAP sources, and 50 lbs. for the RAS sources. Experiment 2 will require 5 random 10 lb. samples from the RAP and fractionated RAP sources, and 5 random 3 lb samples from each RAS source. AAT will

work with the various sources to obtain samples of the materials needed for the project and arrange for shipping of these materials to AAT's laboratory in Sterling, VA.

All testing will be performed by qualified technicians in AAT's AMRL accredited laboratory in Sterling, VA. AAT's laboratory has been accredited since 1996 by AMRL for a wide range of binder, hot-mix asphalt, and aggregate tests. AAT's current accreditation can be found in the AASHTO R18 online directory at:

http://www.amrl.net/Portal/DesktopDefault.aspx?tabindex=99&tabid=49&LaboratoryID=fhNbpwkOyFs*V

Task 4: Data Analysis

In this task, the laboratory data collected in Task 3 will be analyzed. Three major analyses will be completed. The first will be a compilation of summary statistics of the four major sources of recycled materials: RAP, fractionated RAP, RAS from manufacturer sources, and RAS from tear off operations. The second analysis will be aimed at developing an improved blending chart for performance graded binders that addresses the shortcomings listed earlier for the current AASHTO procedure. In the third analysis, the improved blending chart and data from typical Wisconsin sources will be used to evaluate the current Wisconsin DOT criteria for binder replacement and to identify potential effects on pavement performance.

Task 5: Prepare Standard Practice

In Task 5 a standard practice for blending chart analysis for recycled asphalt binders in performance graded binders will be prepared. It is envisioned that this practice will include only minor modifications to the current AASHTO procedure. This standard practice is intended for use in characterizing recycled binders and blended binders for use in mixture design. The standard practice will include an Excel spreadsheet to perform the blending chart analysis.

Task 6: Compile Final Report

The final task, Task 6, includes the preparation and submission of the Final Report for the project, documenting all significant work completed during the project. The report will be prepared in accordance with the Wisconsin Highway Research Program requirements. A Draft Final Report will be compiled by the research team and submitted to the TOC for review and comment. The research team will address the comments, then compile and submit the required number of copies of the Final Report. An electronic database of the laboratory test results will be included with the Final Report. Task 6 includes a closeout presentation by the Principal Investigator to the TOC.

Expected Contribution From WisDOT Staff

The proposed research will require some assistance from the Wisconsin DOT staff to review the experimental design and products of the work and to identify sources of virgin binders and recycled materials for use in the research. The research team does not anticipate the Wisconsin DOT contributions will exceed the 30 hours identified in the request for proposals.

Anticipated Research Results and Implementation Plan

Research Results

There will be five primary research products completed as part of the proposed research:

1. Summary data on recovered binder properties and their variability for typical Wisconsin recycled asphalt sources to include RAP, fractionated RAP, manufacturer RAS, and tear off RAS.
2. An evaluation of current Wisconsin DOT criteria for binder replacement based on an accurate blending chart analysis of typical recycled binders from Wisconsin sources.
3. Recommended modifications to the current criteria for binder replacement based on the positive and negative effects of using recycled asphalt binders.
4. A procedure for developing blending charts for various combinations of recycled and virgin materials to estimate the performance grade of the resulting binder. These blending charts will include reliability and an Excel workbook will be developed to perform the required computations.
5. A final report thoroughly documenting the work completed in the project.

Implementation of the products from this study will result improved HMA mixture design that allows effective use of a variety of recycled asphalt sources and minimizes the risk of premature failure. The increased use of recycled materials will result in a cost savings to the public.

Implementation Plan

The intended audience for the products outlined above is engineers and technicians responsible for HMA mixture design and acceptance. Typically, these are entry to mid-level engineers and experienced technicians working for the Wisconsin DOT and HMA producers. The research team will keep the products produced during this project appropriate to these intended end-users.

Implementation of the products of this research will be straightforward and most can be implemented immediately. The analysis of current Wisconsin DOT criteria for binder replacement will either support these criteria or identify changes that should be considered. It is envisioned that the improved blending chart procedure will include only minor modifications to the current AASHTO procedure, and will not require additional or modified equipment. The improved procedure will be documented in the form of an AASHTO Standard Practice that will describe the testing and analysis that is required. An Excel workbook will be prepared to perform the reliability based blending chart analysis. This tool can be provided to contractors preparing mixture designs using recycled materials.

The most likely impediment to implementation will be resistance from HMA producers to change current binder grades when using recycled materials. This resistance may limit the amount of recycled binders that can be effectively used in HMA in Wisconsin.

Time Requirements

Figure 4 present the proposed time schedule. The first three months will be used to complete the literature review and develop the experimental design for the laboratory work. The experimental plan will be completed in the second month of the project. A presentation of the experimental design will be made to the TOC in the 3rd month of the project. Six months have been provided for the laboratory testing and data analysis, and one month for the preparation of the standard practice. The Draft Final Report will be submitted at the end of the 12th month of the project. Three months are provided for preparation and submission of the Revised Final Report. The close out presentation will be made in the 13th month of the project.

Task/Activity	Contract Month														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Task 1: Literature Review	X	X													
Task 2: Experimental Design		X	X												
Task 3: Laboratory Testing				X	X	X	X	X	X						
Task 4: Data Analysis					X	X	X	X	X	X					
Task 5: Prepare Standard Practice											X				
Task 6: Compile Final Report												X	X	X	X
<i>Presentations</i>			X										X		
<i>Quarterly Reports</i>				X			X			X			X		
<i>Experimental Plan</i>		X													
<i>Draft Final Report</i>												X			
<i>Revised Final Report</i>															X

Figure 4. Project Schedule.

The project is estimated to require 662 man-hours of effort. Table 5 summarizes the level of effort by task and individual.

Table 5. Planned Effort by Task.

Individual	Role	Tasks						Total
		1	2	3	4	5	6	
Bonaquist	Principal Investigator	16	16	8	32	8	40	120
Jack	Lab Manager	0	0	20	0	0	0	20
Bennett	Senior Technician	0	0	174	0	0	0	174
D. Tederick	Senior Technician	0	0	174	0	0	0	174
P. Tederick	Technician	0	0	174	0	0	0	174
Total		16	16	550	32	8	40	662